Metalorganic Structure as a Template for Anisotropic Thin Film Ceramics

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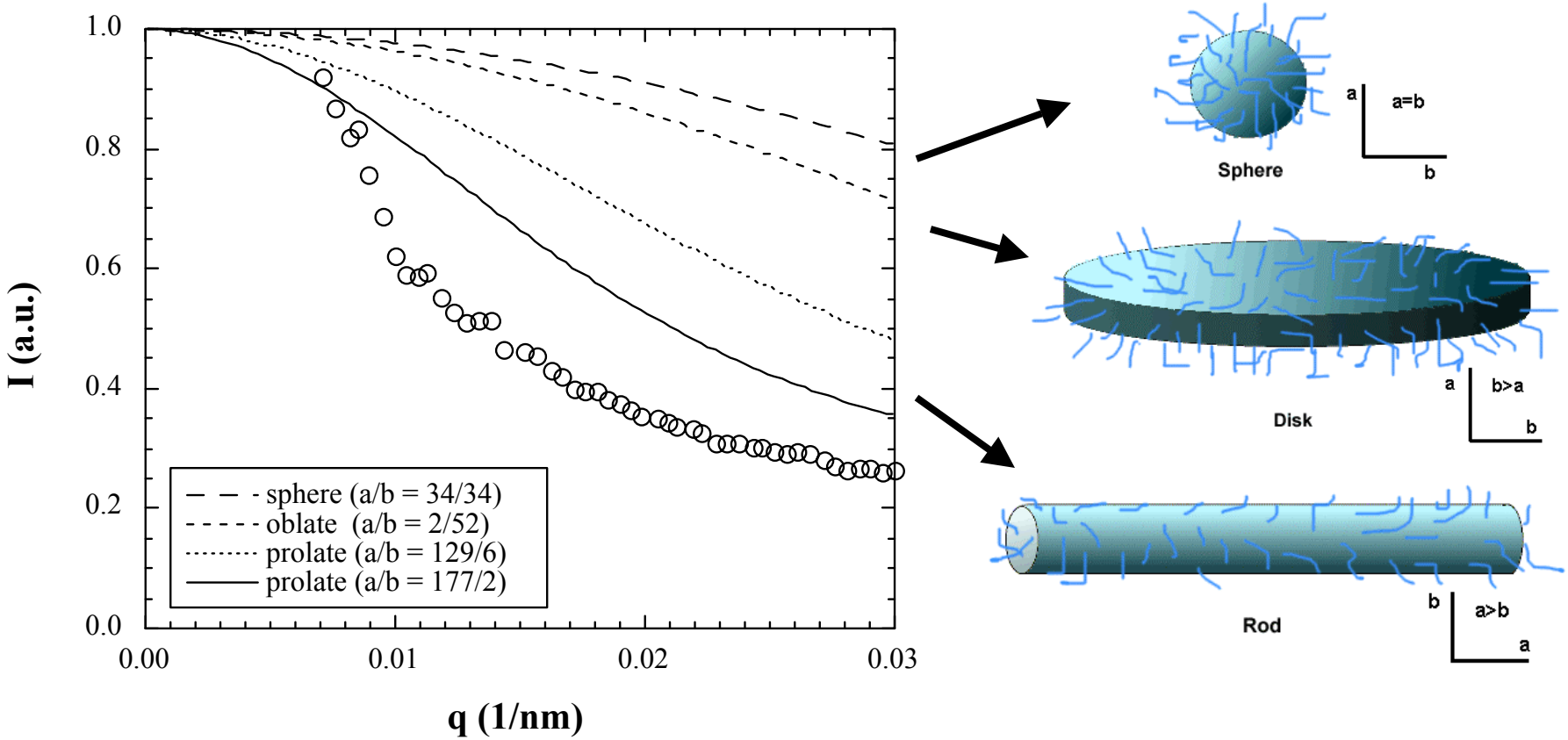

Scattered light intensity vs scattering vector for nano-particles of the same equivalent spherical diameter, but different shapes. Experimental data (circles) for a $Bi_4Ti_3O_{12}$ precursor sol aged for 60 days suggest that molecular clusters are approximated as prolate (rod-shaped) or chainlike.

The ageing characteristics of a metal-alkoxide solution, used to prepare thin films of ferroelectric bismuth titanate, $Bi_4Ti_3O_{12}$, were carefully scrutinized using laser light scattering. Dynamic light scattering experiments revealed a bimodal distribution of hydrodynamic diameters, with larger molecular clusters increasing in size from 4 to 68 nm over the course of 60 days ageing in a sealed vial. Static light scattering measured the radius of gyration to be 71 nm. Comparison of these two results suggests that these clusters are approximated as thin cylindrical (or chainlike) structures. Using ellipsoid scattering theory, plots of scattered light intensity versus q (scattering) vector also suggest a long cylindrical type cluster with a length of ~350 nm and a diameter of ~ 4 nm. Some deviation of experimental data from the theoretical curves probably is an indication of some flexibility and/or fractal nature of the molecular clusters.

The anisotropy in oligomeric cluster shape apparently has a strong influence on final crystallographic texturing of ceramic thin films made by spin-coating of these solutions on flat substrates. Using properly aged solutions, $Bi_4Ti_3O_{12}$ films with nearly 50% c-axis orientation have been produced repeatedly on a number of substrates, including glass. Highly textured polycrystalline films can have superior electrical and other physical properties. The ability to produce such ceramic films, without relying on epitaxial growth from exotic and expensive single crystal substrates, would be very beneficial.